Using Xgrid to Create and Deploy Distributed Computations

Session 616

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Enterprise IT

Using Xgrid to Create and Deploy Distributed Computations

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Xgrid Engineering

http://developer.apple.com/wwdc2005/

Xgrid Overview

http://developer.apple.com/wwdc2005/

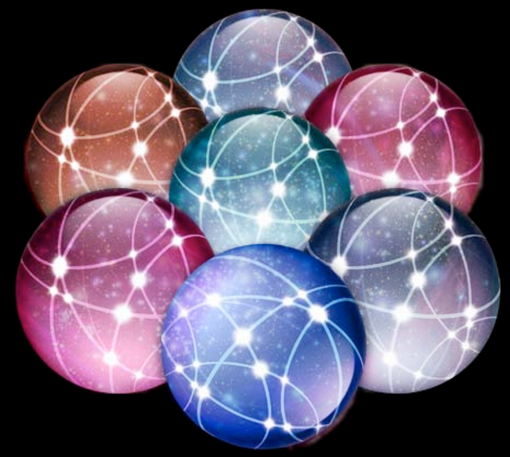
What You'll Learn

- Overview
- Architecture
- Administration
- Job Submission
- Development

Introduction

- Xgrid is Apple's distributed computing solution
  - Allows distributed processing of "grid" jobs to make work go faster
- Tiger Server comes with Xgrid
  - Xgrid agent runs on desktop machines
    - Built-in to Tiger, install available for Panther
- Tiger Developer Tools includes support for Xgrid frameworks and can be used to develop grid software

Xgrid History



January 2004	March 2004	April 2005
Technical Preview	Technical Preview 2	Tiger

What Solutions Does Xgrid Enable?

- Makes distributed computing painless
  - Built-in support in Tiger and Tiger Server
    - Administration tools provided with Tiger Server
  - Xgrid agent available for installation on Panther
  - Allows people-friendly sharing of resources
- Supports various distributed computing styles
  - Dedicated participants (Beowulf)
    - Racks of Xserves or closets of Mac minis
  - Part-time participants (SETI@Home)
    - Underutilized office and university computers
    - Idle cycle recovery on global scale

Who Can Benefit From Xgrid?

- System administrators
  - Simplifies setup and maintenance
  - Can be a service like mail, file, or print—grid is maintained by IT department but used by scientists
- Software developers
  - Allows existing applications to be grid-enabled
- Scientists and engineers
  - Persistent job queue supports fire and forget job submission
  - Grid works on your job while you are home with your family
- Creative professionals
  - Lots of potential in the creative markets for grid enabled content creation software

Terminology

- Xgrid is simple, but terms help clarify the roles computers take on when they are using or part of a grid
  - Client—scientist's PowerBook
    - Has work that needs be done
  - Controller—Xserve G5
    - Manages jobs, scheduling, data movement, and agents
  - Agent—high-end dual 2.7GHz G5s or older underutilized Blue and White G3s
    - Work is scheduled and executed on agents
    - Work that can be sufficiently broken up will run in parallel on as many agents as there are available

Three Tier Architecture

Clients

Controller

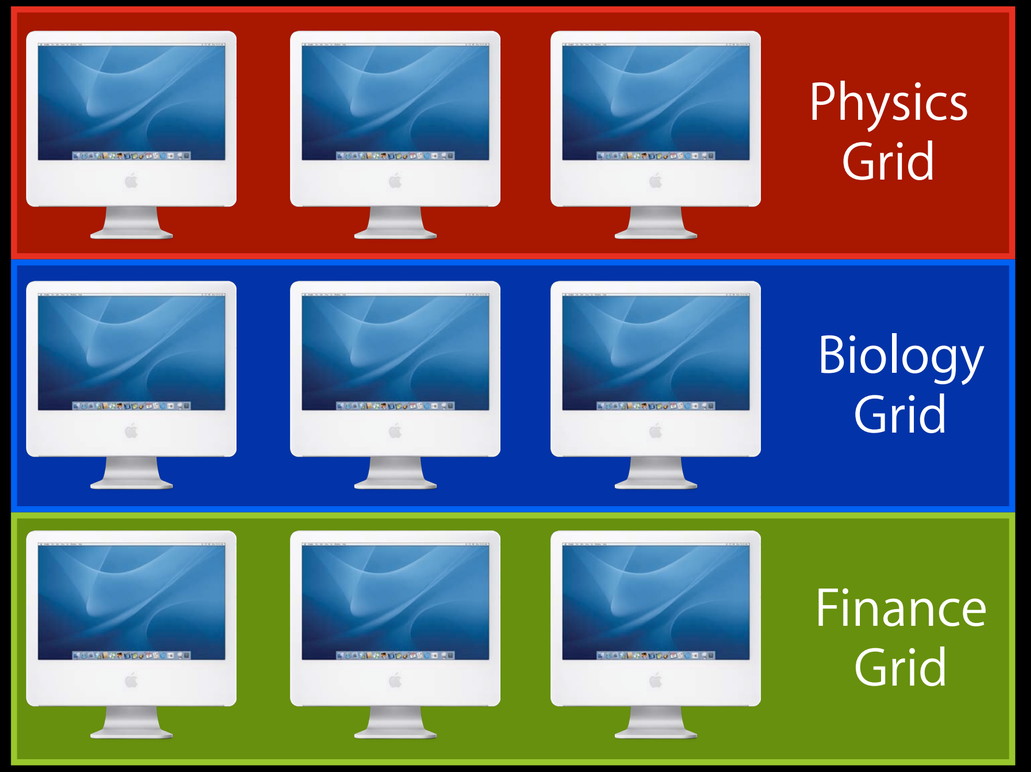
Agents

Terminology

- Grid
  - Set of agents
  - Job queue
- Job
  - Set of tasks
  - Collection of input and output data
- Task
  - The smallest piece of work done by an agent
  - Command-line executable
  - Arguments
  - Working directory files
  - Standard input

Three Tier Architecture

Partitioning Agents into Grids



Clients **Controller** **Agents**

What Does Xgrid Do?

- Groups agents into grids
- Monitors agent availability
- Manages queues of jobs and their dependencies
- Schedules runnable jobs to be executed by available agents
- Handles data staging
  - Copies job executables and input data from client to agent
  - Copies output data from agents back to the client
- Recovers from failures
  - Reschedules tasks that were running on failed agents
  - Persists jobs across controller downtime

New Features in Tiger

- Kerberos authentication
- Cocoa developer API
- Server Admin integration
- Xgrid Admin application
- Multiple tasks per job
- Task and job dependencies

Where Are The Components?

- Tiger comes with:
  - Agent daemon and Sharing prefs integration
  - Client framework and CLI tool
  - Code examples (Developer Tools)
- In addition, Tiger Server comes with:
  - Controller daemon
  - Administration applications

Where Are The Components?

- Available for Panther
- Agent daemon and a separate prefpane

Message Passing Interface Support

- Sample code shows how to submit MacMPI jobs
  - /Developer/Examples/Xgrid/GridSample/MPI
- OpenMPI has modified their mpirun command to use Xgrid
  - www.open-mpi.org/

Xgrid Architecture

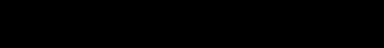
http://developer.apple.com/wwdc2005/

Three Tier Architecture

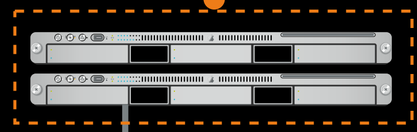
Client, Controller, and Agent

Detachable clients
Submit jobs, then either wait for or be notified of results

Controller
Split job into tasks, resubmit failures, retrieve results



Full-time Agents
Dedicated exclusively to running Xgrid tasks



Part-time Agents
Run Xgrid tasks when users are not active (also known as desktop recovery or screensaver mode)

Computer labs

Workstations

Internet Agents
Volunteer to help with large-scale "@Home" calculations

Security

- Authentication
  - None, Password, Kerberos
- Privilege separation
  - Controller runs as user ‘xgridcontroller’
  - Agent runs as user ‘xgridagent’
  - Agent helper runs as ‘root’
- Task privileges
  - Tasks run as user ‘nobody’ if None or Password authentication is used
  - Tasks run as submitting user if Kerberos authentication is used

Authentication Modes

- No password
  - Suitable for private networks ONLY
  - Anyone can connect to the controller
- Password
  - Two shared secrets; one for all clients, one for all agents
  - Suitable for SOHO setups, or personal grids at large organizations
- Kerberos
  - Most secure; confidentiality in addition to authentication
  - Requires a directory system and a KDC
  - Client access controlled via Service ACL
  - Agent access controlled by existence of principal in KDC database

Agent Privilege Separation

started by launchd,
runs as ‘xgridagent’

xgridagentd

xgridagenthelper

started by xgridagentd,
runs as ‘root’

task

started by xgridagenthelper, runs
as ‘nobody’ or as submitting user,
returns results directly to xgridagentd

Discovery and Authentication

Easily connect across subnet, organization, or Internet

Client

4 Clients locate Controller using BonJour, DNS, or IP address

5 Clients and Controller mutually authenticate using passwords or Kerberos

1 Controller advertises via BonJour

Controller

2 Agents locate Controller using BonJour, DNS, or IP address

3 Agents and Controller mutually authenticate using passwords or Kerberos

Distributed Agents

Dedicated Desktop

Dedicated Server

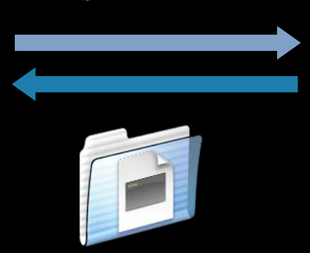
Part-time Desktop

Xgrid Workflow

Submit, Monitor, and Retrieve

Client

1 Client submits job to Controller



8 Client retrieves job results from Controller

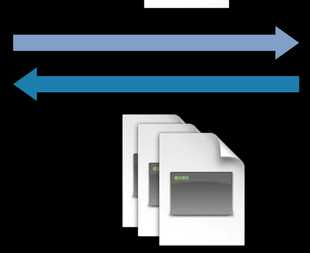
2 Controller schedules the job and splits it into tasks

Controller

5 Controller monitors tasks, re-submits as needed

7 Controller collects task results and notifies Client of job completion

3 Controller submits tasks to Agents



6 Agents return results to Controller

Distributed Agents

4 Agents execute tasks

Dedicated Desktop

Dedicated Server

Part-time Desktop

Xgrid Job Submission

http://developer.apple.com/wwdc2005/

Audio Encoding Demo

http://developer.apple.com/wwdc2005/

Xgrid Administration

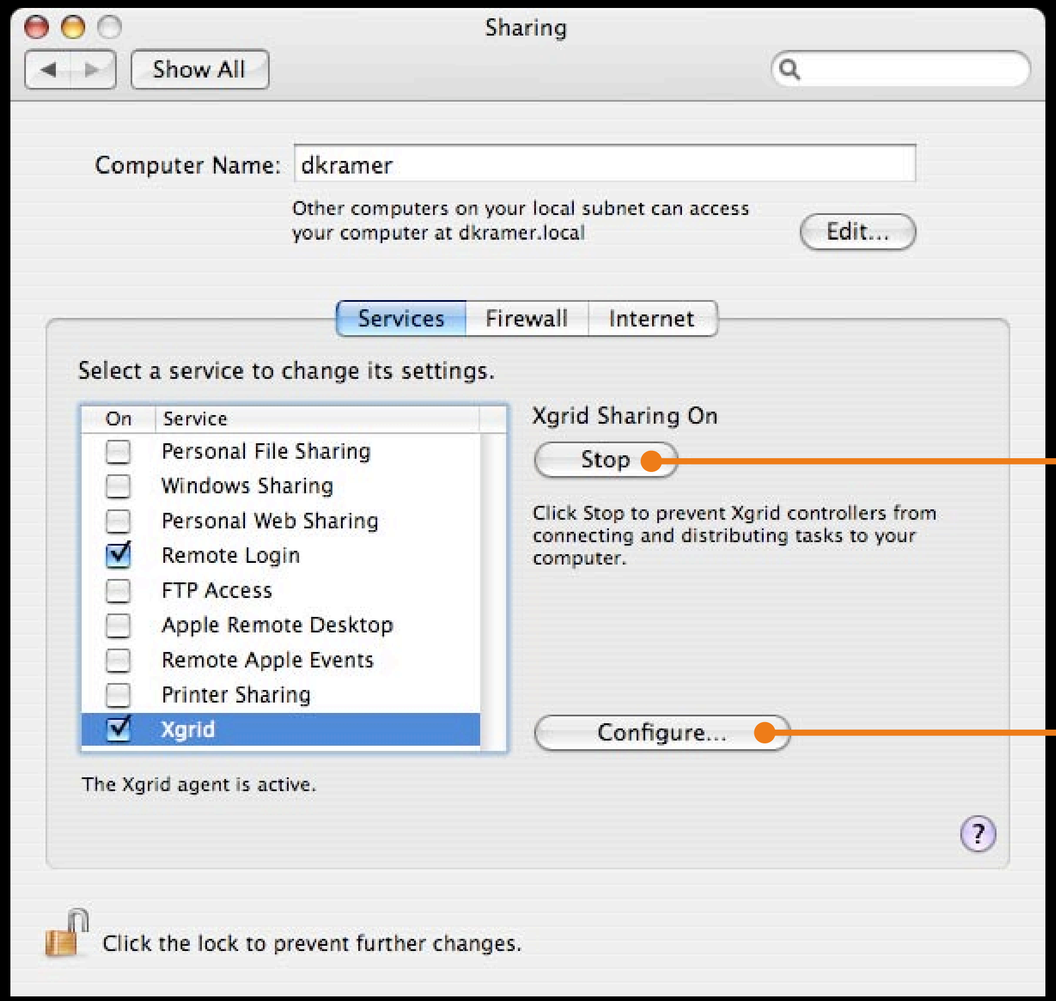
http://developer.apple.com/wwdc2005/

Xgrid Administration

- Sharing Preferences configures Tiger agent
- Separate prefpane configures Panther agent
- Server Admin configures Tiger Server agent and controller
- Xgrid Admin configures grids and monitors jobs and agents

Sharing Preferences

Overview

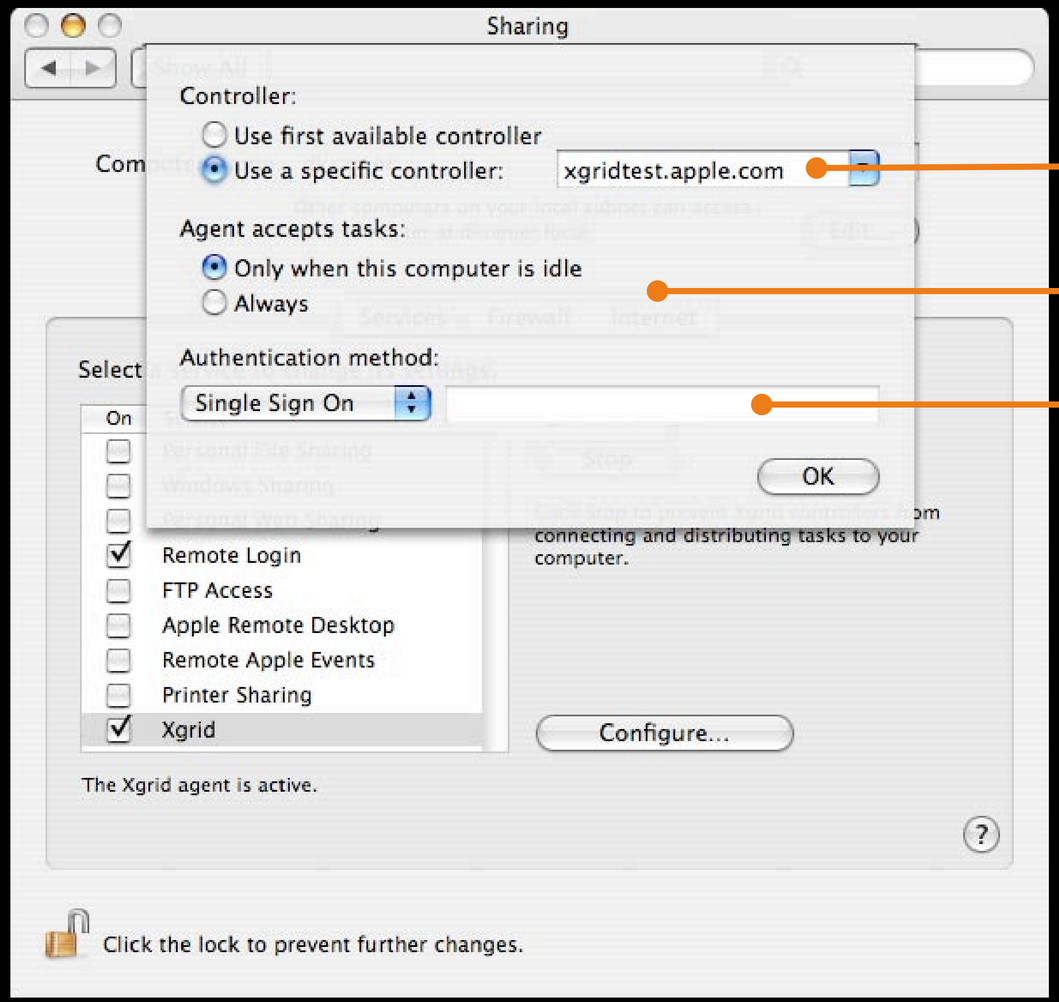


Start and Stop
Toggles the state of the agent between On and Off

Configure
Toggles the state of the agent between On and Off

Sharing Preferences

Configuration



Controller
Choose a controller to bind the agent to

Dedicated vs. Part-time
Choose if the agent should reject tasks when not idle

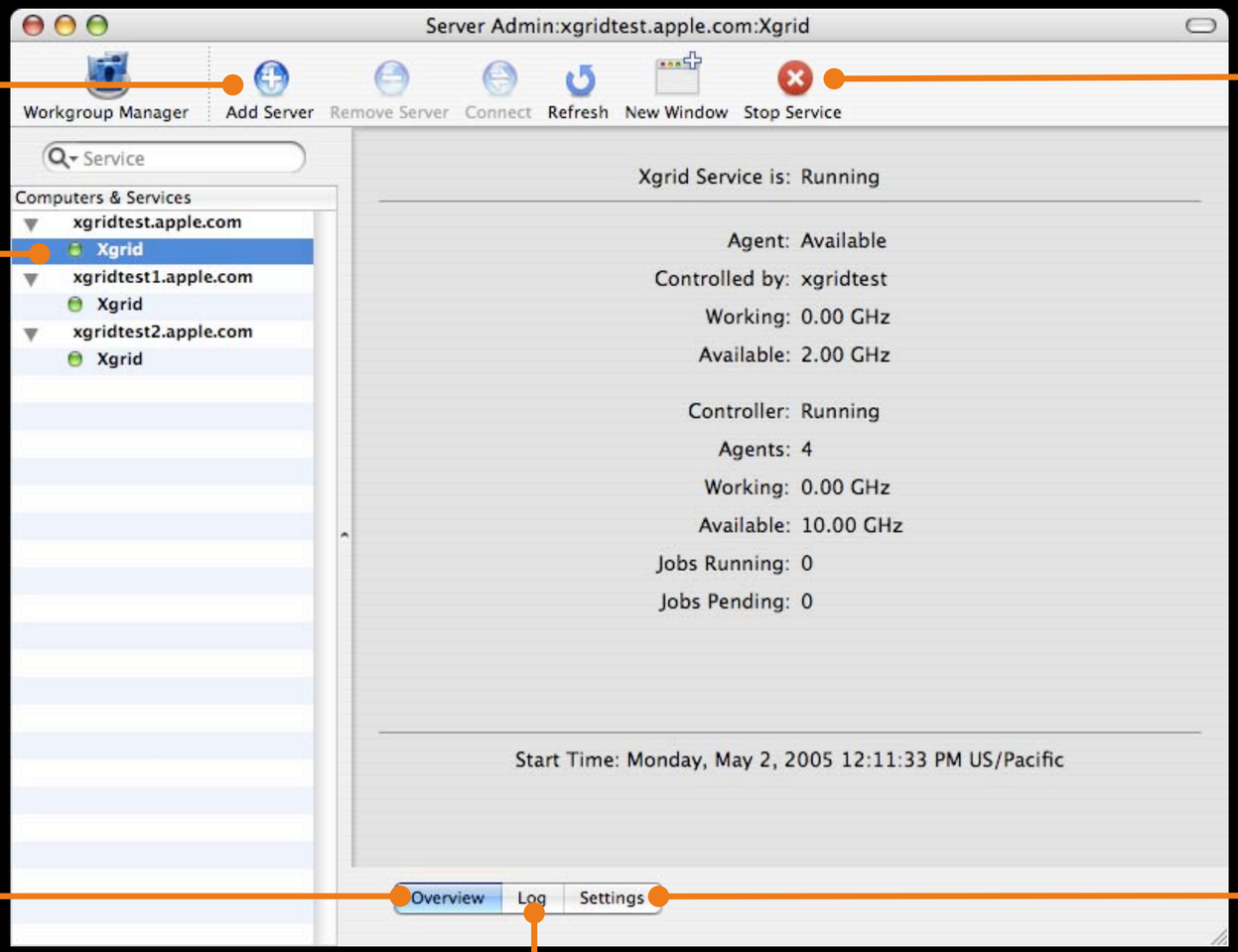
Authentication
Choose from “None”, “Password”, or “Single Sign On”

Server Admin Plug-In

Overview

Server
Add the servers to setup services on

Service
The service to be configured



Start/Stop button
Starts the enabled Xgrid services on the selected computer

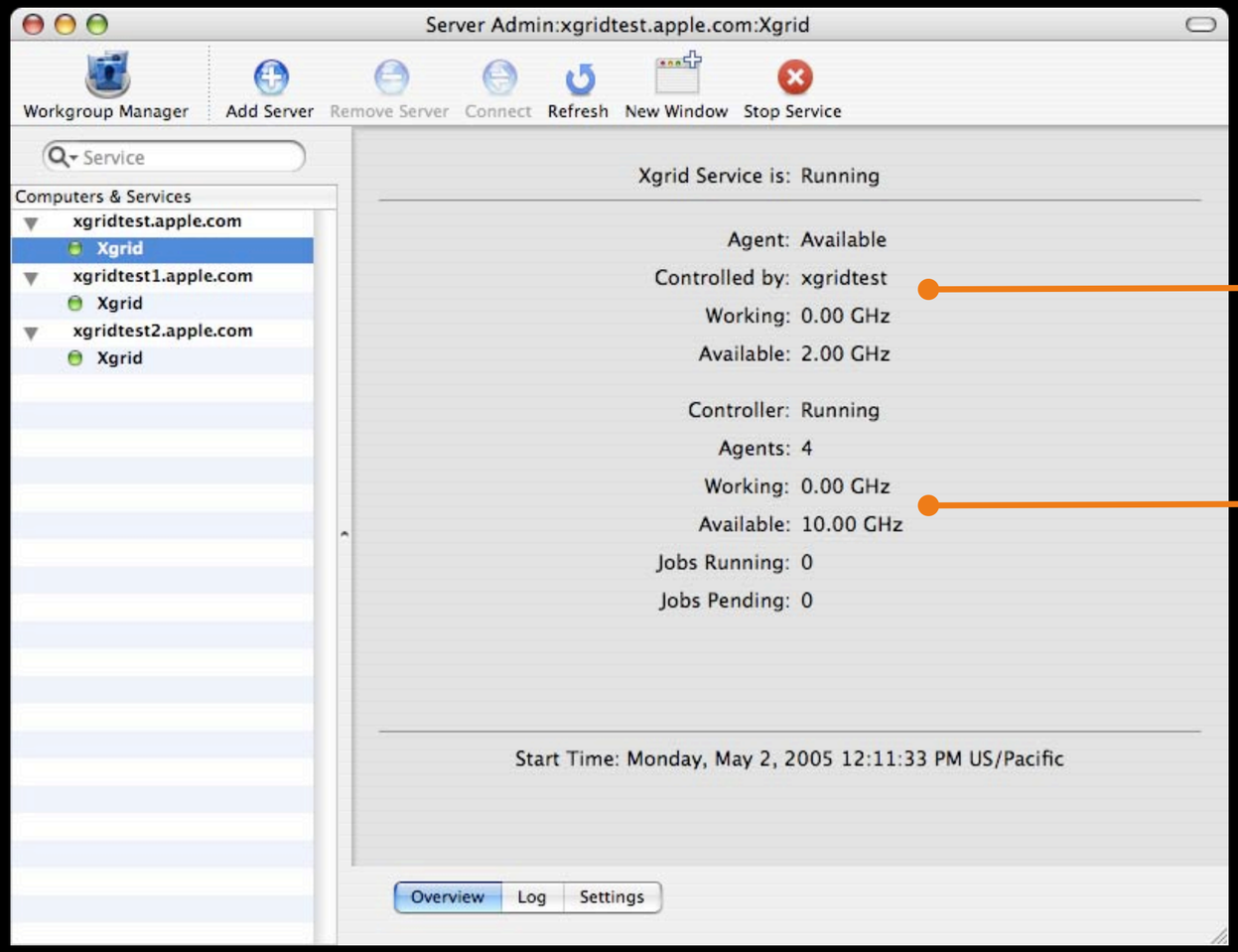
Overview
Show general statistics about the agent and controller

Log
Show the Xgrid log messages from the system log

Settings
Edit the configuration for the controller and agent

Server Admin Plug-In

Overview



Agent Statistics
Shows a summary of the agent's status

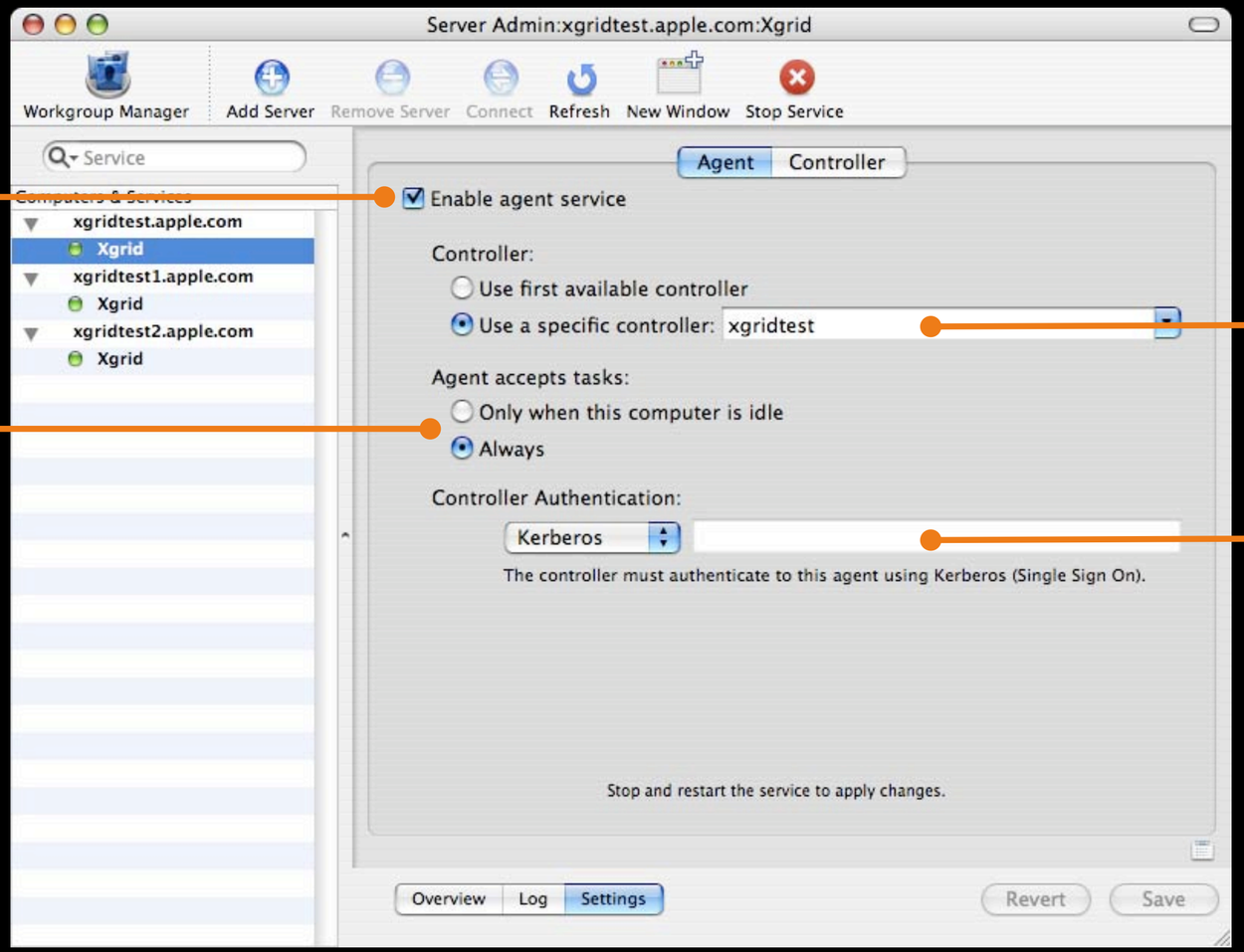
Controller Statistics
Shows a summary of the controller's status

Server Admin Plug-In

Agent Settings

Enable
Choose if the agent should be started with the Xgrid service

Dedicated vs. Part-time
Choose if the agent should refuse tasks when not idle



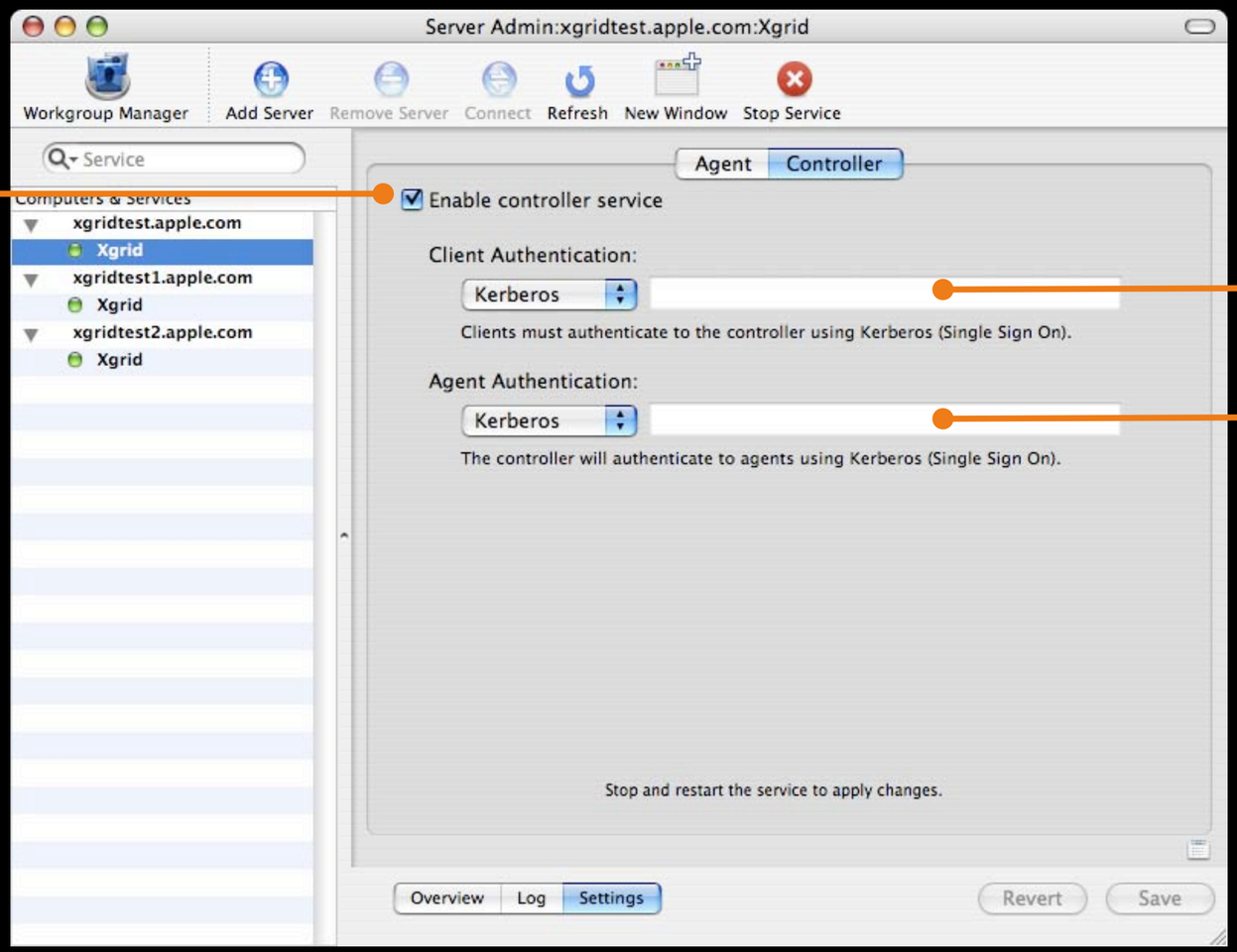
Controller
Choose which controller to bind this agent to

Authentication
Choose from “None”, “Password”, and “Kerberos”

Server Admin Plug-In

Controller Settings

Enable
Choose if the controller should be started with the Xgrid service

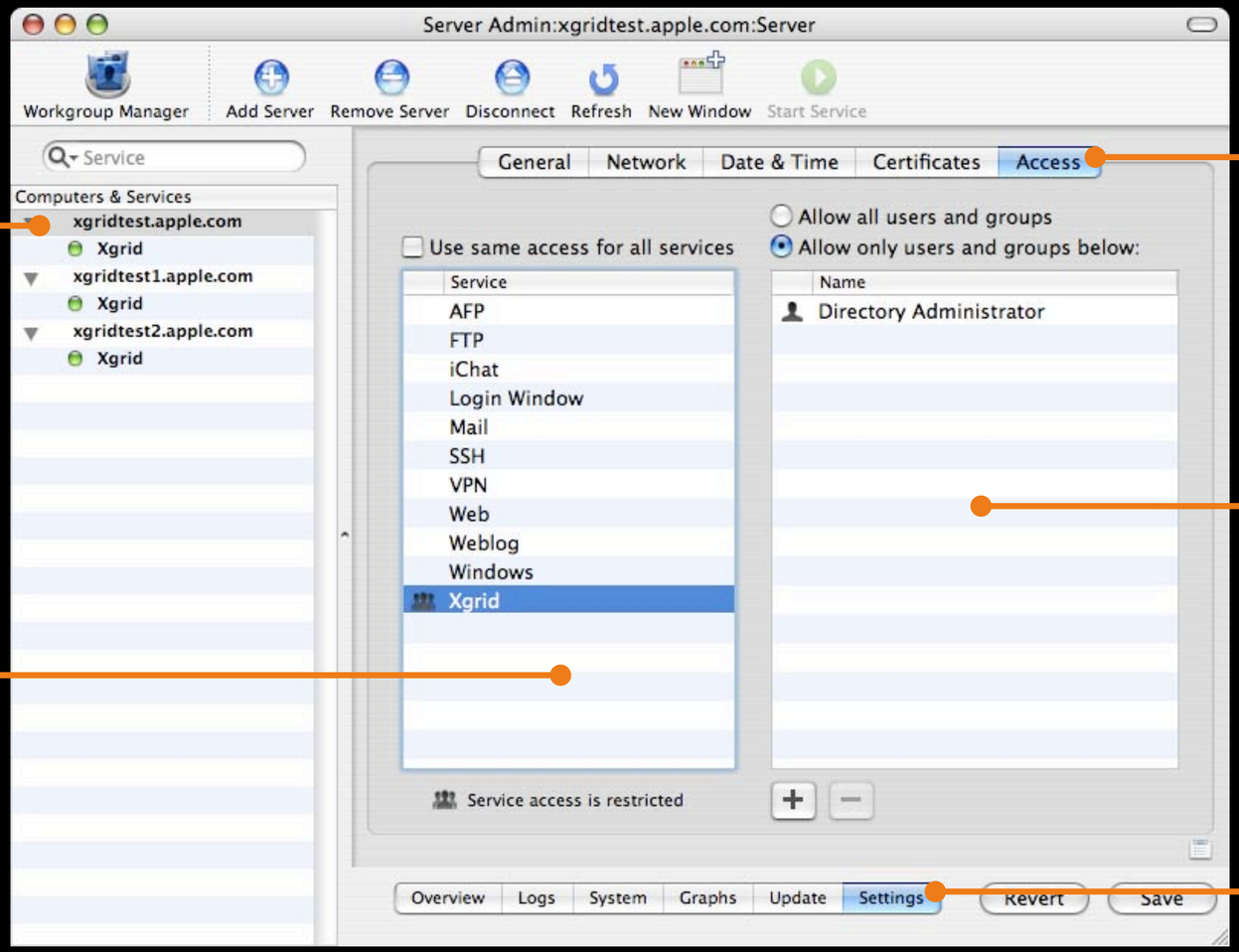


Client Authentication
Choose from "None", "Password", and "Kerberos"

Agent Authentication
Choose from "None", "Password", and "Kerberos"

Server Admin Service ACLs

Xgrid Client Access Control



Computer
The computer running the services being administered

Services
Choose the service to which to control access

Access
Edit the service access control lists

Users and Groups
Edit the list of allowed users and groups

Settings
Edit the configuration for the computer

Xgrid Admin

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Xgrid Admin

Overview

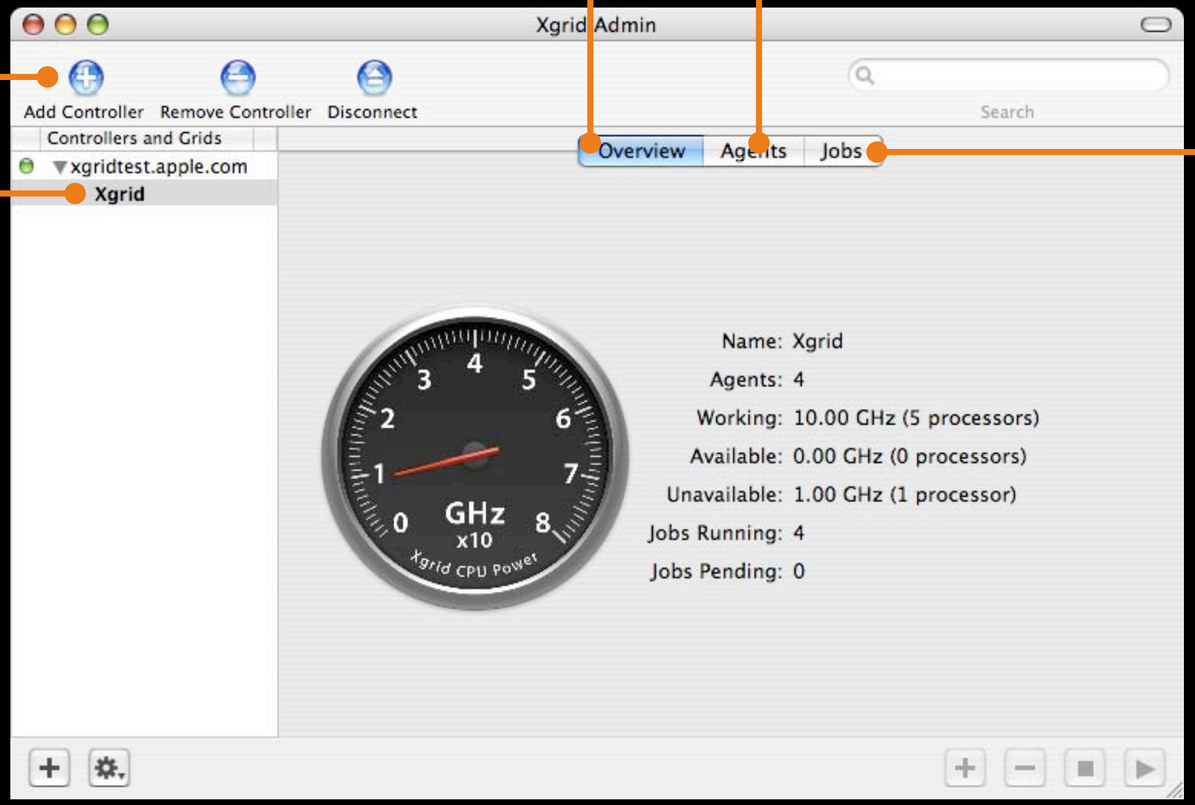
Overview
Tachometer showing aggregate CPU power of all active agents

Agents
Monitor, remove, or reassign specific agents

Controllers
Automatically discover or manually add new Xgrid controllers

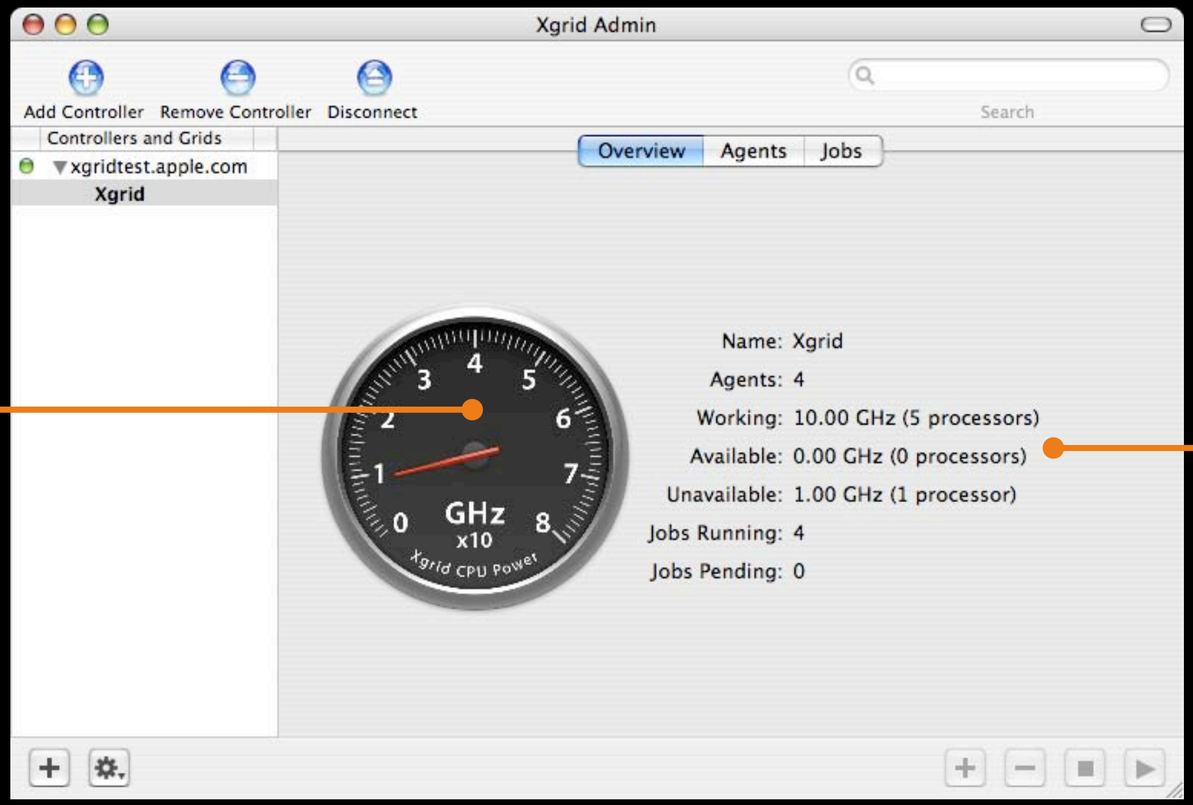
Grids
Agents for a given controller can be split into multiple grids

Jobs
Monitor, pause, resume or delete jobs



Xgrid Admin

Overview

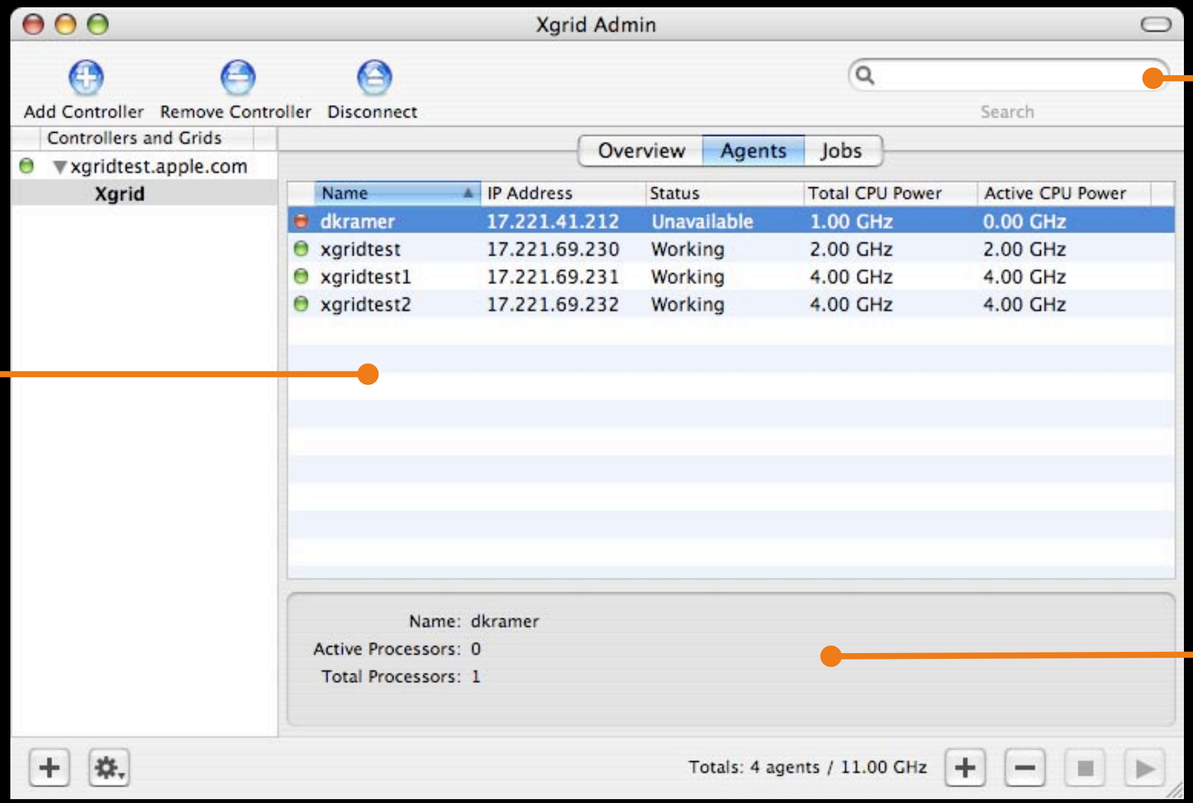


Tachometer
Quickly see the working CPU power of the controller or grid

Statistics
Show details for a particular controller or grid

Xgrid Admin Application

Agents



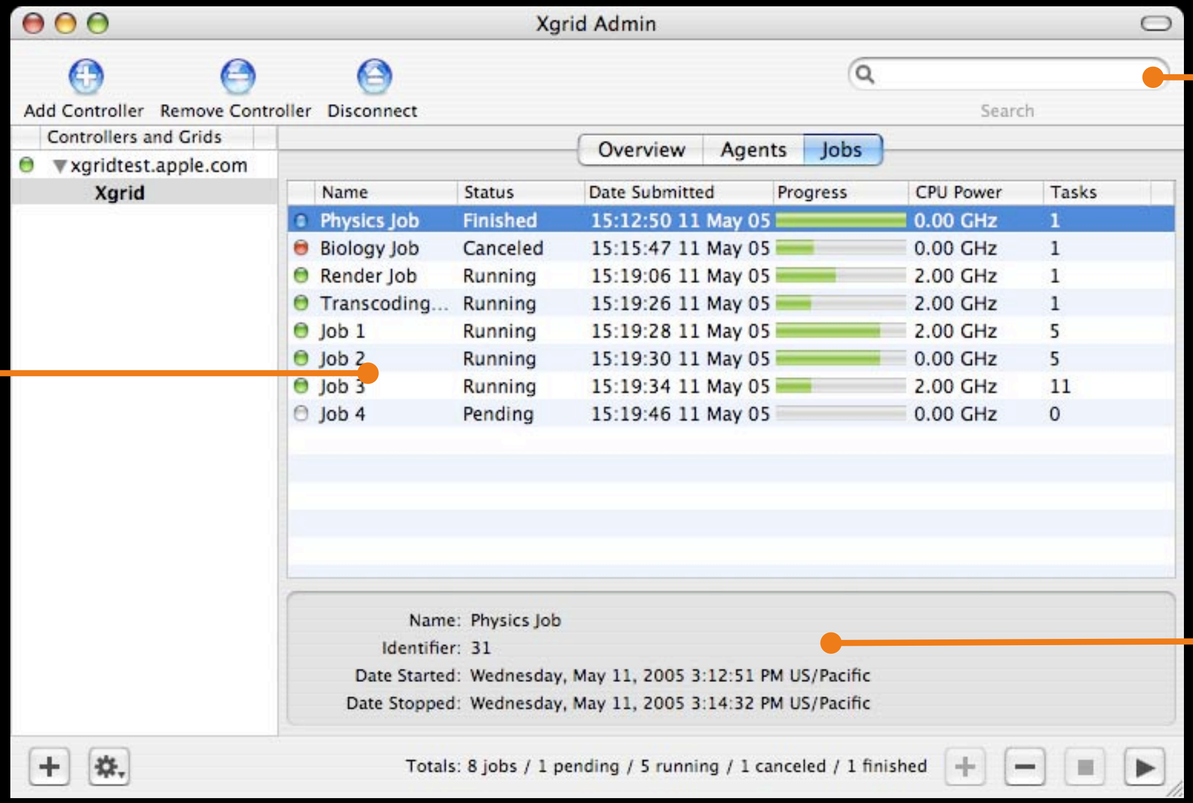
Search
Quickly find a given agent or job, even on large networks

Agent List
Monitor agent availability and activity

Statistics
Show details for a particular job or agent

Xgrid Admin Application

Jobs



Search
Quickly find a given agent or job, even on large networks

Job List
Monitor job attributes and progress

Statistics
Show details for a particular job or agent

Xgrid Development

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Calendar Code Example

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More Information

http://developer.apple.com/wwdc2005/

Documentation, Sample Code, and Other Resources

http://developer.apple.com/wwdc2005/

WWDC2005

Worldwide Developers Conference